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ABSTRACT

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Forgetting of Prose as a Function of Interpolated Passage Content and Organization

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Running Head: Forgetting, Passage Content, and Organization

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Abstract

In three studies subjects read two successive passages and then were tested for retention of the first. Each passage described the characteristics of a series of entities (diseases or countries) along a series of dimensions (symptoms, cause, etc; or climate, soil type, etc). The first passage described 5 diseases and was organized by name; each paragraph treated a different disease in turn. Second passages were either name-organized or dimension-organized (each paragraph treats a different dimension), and discussed one of three different contents. We had expected a change in organization from first to second passage would reduce interference. Instead the effect of a change in organization was moderated by the structural relationships that existed between the original and interpolated passages. Experiment 3 demonstrated that when subjects were made aware of the underlying structure of the passages, retroactive inhibition was eliminated. These findings have implications for understanding the nature of the memory structures and encoding strategies employed by subjects while learning from reading.

Forgetting of Prose as a Function of Interpolated Passage Content and Organization

Several studies have demonstrated that specific associative information acquired from prose passages is subject to retroactive inhibition as predicted by interference theory (Anderson, 1972; Anderson & Carter, 1972; Anderson & Myrow, 1971; Andre, 1973, 1975; Bower, 1974; Crouse, 1971; Haveman, 1972). Such inhibition occurs only when two passages teach competing responses to similar questions (e.g., Passage 1, The tribesmen are tall and thin. Passage 2, The tribesmen are short and chunky. Question, What did the tribesmen look like?) and is specific to such competing responses. Other information in the passage does not suffer interference (Anderson & Myrow, 1971; Bower, 1974). For example, Bower (1974) demonstrated that when the surface organization of the passages was identical, specific information would be forgotten, but memory for the organization would be enhanced. Andre, Anderson, and Watts (1974, 1976, in press) have demonstrated that, in the free recall of noun lists, a change in organization from one list to another could reduce item specific interference. The present studies sought to determine the effect of a change in organization on interference processes in prose materials.

In the Andre, et al (1974) studies subjects were told to recall the list of nouns either in alphabetical order or by common taxonomic categories. Each subject learned two lists and was then tested for retention of the first list. When subjects used the same strategy on both lists, recall of first list words was poorer than when subjects used the alphabetize strategy on one list and the clustering strategy on the other. This result cannot be directly translated to prose work, since with prose passages it is much more difficult to inform subjects to use a particular strategy. The present study took advantage of a procedure introduced by Frase (1969) to control the organizational processes employed by subjects.

Frase (1969) wrote passages based upon matrix structures such as those illustrated in Table 1. Such structures relate each of a series of entities to the values those entities possess on each of several dimensions. The matrix in Table 1D, for example, attributes the values, monsoons, damp, rope, and flat to the entity (Country) Anglar on the dimensions of climate, soil, industrial product, and landscape respectively. Each cell in such matrices is used to form a sentence which predicates the cell value to that entity on that dimension: e.g., The soil of Anglar is damp. Obviously there are as many sentences as there are cells in the matrix.

Passages based on such matrix structures may be either organized by name, organized by dimension, or randomly organized. In a name-organized passage all the attribute values for one entity are specified before the next entity is mentioned. In dimension-organized passages, the attribute values for all entities on a particular dimension are stated before the next dimension is mentioned. In other words name-organized passages read sequentially across the rows, while dimension-organized passages treat each column in turn. Randomly-organized passages represent a random arrangement of the sentences.

Frase (1969) found that organized passages were learned more quickly than random passages. Subsequent research has confirmed this finding (Frase, 1973; Friedman & Greitzer, 1972; Myers, Pezdek, & Coulson, 1973; Perlmutter & Royer, 1973; Schultz & Divesta, 1972). More importantly for the purpose of the present study, dimension- and name-organized passages appear to lead to different representations in memory. That is, subjects who learned a name-organized passage seem to store a different organizational structure for the passage than subjects who learned a dimension-organized version. This fact was used in the present studies. All subjects read a name-organized first passage, then read potentially conflicting or neutral second passages. The second passages were either name- or dimension-organized. We expected that a

change in organization from first to second passage would reduce interference. Therefore we predicted that subjects reading dimension organized second passages would recall more of the first passage.

Three types of conflicting passages were used. The first passage described the characteristics of five diseases on four dimensions. One type of second passage described the characteristics of these same five diseases on four new dimensions. This would be similar to a practical case of learning further information about something already studied. For example one might study the agriculture and industry of a country, then study its art and social customs. The second type of passage described the attributes of five new diseases on the dimensions used in the first passage. An analogous real-life situation would be learning about the agriculture and industries of two sets of countries. The third type of conflicting passage described five new countries on four new attributes. A practical analogue would be learning about the agriculture and industry of one country and the social customs and art of a second. The use of three types of conflicting passages allowed us to examine interference processes in a wider range of common educational situations.

General Method

The three experiments reported used the same general procedures and materials. This section describes those procedures and materials, the specific design of each study is discussed with that study.

Materials: The materials in these studies consisted of nine different passages, a free recall retention test. All subjects read the same first passage. This passage contained five short paragraphs of four sentences each. The passage was organized by name; that is, each paragraph was headed by the name of a disease and each sentence in the paragraph stated an attribute of the disease on the dimensions of organ effected, symptom,

cause, and prevention respectively. Table 1A shows the structure from which the first passage was derived. The first paragraph in the passage read as follows: "Silicosis is a disease that affects the lungs. Its major symptom is a severe shortness of breath. It is caused by inhalation of dust. It can be prevented by wearing face masks." Sentences in each of the paragraphs used the same syntactical structure and the order of dimensions was the same in each paragraph.

Insert Table 1 here

Eight different second passages were used; each passage described one of four different contents and was either name or dimension organized. The New Dimensions passages described the attributes of the five diseases used in the first passage on four new dimensions (Age Group, Duration, After Effects, Treatment). The underlying structure of the New Dimensions passages is outlined in Table 1B. The New Diseases passages presented the attributes of five new diseases on the dimensions used in the original passage. Table 1C describes the content of the New Diseases passage. The New Diseases-and-Dimensions passages described the attributes of the five new diseases on the new dimensions of Age Group, Duration, After Effects, and Treatment. Table 1D summarizes the structure of the New Diseases-and-Dimensions passages. The Countries passages described attributes of five fictional countries on four dimensions. Table 1E describes the matrix structure of the Countries passage.

The second passages were written in either name-organized or dimension-organized versions. The name-organized versions were similar in format to the first passage; each paragraph was headed by the name of an entity, i.e., disease or country, and each sentence in the paragraph related an attribute to an entity. The order of attributes within paragraphs was the same as the order in Table 1. Sentences in name-organized passages employed the form

illustrated above for the first passage. Dimension-organized passages contained four paragraphs of five sentences each. Each paragraph was headed by the name of a dimension; the sentences in the paragraphs gave the attribute of each entity on that dimension. The order of entities within paragraphs followed Table 1. An example of a paragraph from a dimension-organized passage is: "The duration of Silicosis is life. The duration of Pancreatitis is 4-6 days. The duration of Varicella is 14-21 days. The duration of Bacillus is 3-4 weeks. The duration of Rubeola is 10-14 days."

The diseases used in the passages were real, but the attributes asserted were not necessarily medically accurate. Some of the attributes had been changed to minimize overlap between the attributes. The countries described were purely fictional.

The materials used in all experiments were essentially the same. Some attributed characteristics were changed between Experiment 1 and 2. In Experiment 1 and 2 the passages were prepared in booklets of alternating study and test pages. There were three study-test pairs on each of the two passages contained in each booklet. The study pages contained a title centered on the top of each page (Diseases or Countries), and four or five paragraphs each headed by a left justified subtitle which was either the name of an entity or dimension. Headings and titles were typed in all caps. At the bottom of each page the statement, "Stop; do not go on until told to do so," was typed in all caps. In Experiment 3 overhead transparencies of the passages were prepared and the passages were presented in that manner. The format of the transparancies were identical to the format used in Experiment 1 and 2. Test pages contained directions to recall the passage just read, a space to recall the passage, and the stop message described above. The study and retention tests used in Experiments 1 and 2 consisted of a free recall page which requested people to recall as much of the first passage studied as possible. In Experiment 3 subjects

were presented with an empty 5 X 4 matrix and asked to fill in the appropriate attributes. Directions for both the learning-trial and retention-test recall pages told individuals to reproduce as much of the passage as possible, not to be afraid to guess, and to write down part statements if they could not remember something fully.

General Procedure: The subjects participated in groups of 1 to about 20. Subjects appeared at a session convenient to them. In Experiments 1 and 2 subjects were unsystematically assigned to conditions by randomly ordering the passage booklets and distributing the top booklet to each subject as he arrived. In Experiment 3 conditions were randomly assigned to sessions; each condition was run at least twice. In all studies (except as noted in Experiment 2) all sessions were completed within a two week period. The individuals were given a few minutes to read the general directions on the cover page of the booklet. These directions informed subjects that they would receive three study-test trials on each of two passages; to recall as much of each passage as they could on each trial; to recall in any order they wished; and that they would receive a final test on the material after study. When all persons indicated they understood, the first study-trial began. The proctor told subjects to turn to the first study page, or to study the projected passage, then allowed 1.5 minutes for study. After that interval the proctor told subjects to turn to the recall page; and gave them 3.5 minutes for recall. Study-test trials continued with this procedure for three trials on the first passage and three trials on the second passage. The proctor then collected the passage booklets and distributed the retention test booklets. The subjects were given 3.5 minutes to complete the final free-recall retention test. Subjects left as they completed the test.

Experiment 1

Design: Experiment 1 was a retroactive inhibition experiment involving two substantive variables: content of interpolated (or second) passage (Content) and organization of interpolated passage (Organization). Each subject studied each of two passages for three study-test trials and then took both an immediate retention test. All groups read the same first passage, then studied one of six different second passages. There were three interpolated passage contents: the New Dimensions content, the New Diseases-and-Dimensions content and a Countries content; and two types of organization: Name or Dimension. There were 5 groups formed from the orthogonal combination of the two variables, with the exception that the Dimension-Organized Countries Condition was not used. Thus the 5 groups were New Dimension-Name Organized, New Dimension-Dimension Organized, New Diseases-and-Dimension-Name Organized, New Diseases-and-Dimension-Dimension Organized, Countries-Name Organized. The 4 groups who read second passages concerned with disease can be considered experimental groups, the Countries group can be considered a control. The learning data were analyzed using a 5 (Groups) X 3 (Trials) analysis of variance with repeated measures on trials. The analysis of the recall data were analyzed using a 2 (Content) by 2 (Organization) analysis of variance. Dunnette's test was used to compare performance of the experimental groups to the control. Since the number of subjects per cell were unequal, the unweighted means procedure was used.

Subjects: The people in Experiment 1 were 31 undergraduate students taking Educational Psychology at the State University of New York at Cortland. All received course credit for their participation.

Results

Scoring: Scoring of the learning-trial and retention-test recall tests followed this scheme. One point was given for recalling the name of each

entity and for each correct association between entity and attribute. Errors in spelling, grammar, etc. were ignored so long as the relationship between entity and attribute was clear. The maximum score for each recall was 25, i.e., 5 entity names and 20 possible associations (four per name).

Learning data: In the analysis of the Passage 1 data, only the effect of trials was significant; recall increased over trials in each of the groups. F (2,52) = 78.55, p <.01, MSE = 3.91; Trial 1, $\bar{X}$ = 13.1; Trial 2, $\bar{X}$ = 17.5; Trial 3, $\bar{X}$ = 19.4. A similar result was obtained for Passage 2, only Trials produced significant variation in the data, F (2,52) = 80.11, p < .01, MSE = 5.56; Trial 1, $\bar{X}$ = 11.7; Trial 2, $\bar{X}$ = 16.7; Trial 3, $\bar{X}$ = 19.06. Again, recall increased over trials. The failures to find differences among the conditions suggests that the groups did not differ substantially and that comparisons of the retention scores are meaningful.

Retention Test: On the free recall retention test, only the interaction of second passage Content and Organization proved significant, F (1,23) = 5.37, p <.05, MSE = 7.50. Table 2 contains the mean recall scores. As can be seen in Table 2, name-organization produced better recall than did dimension-organization for the New Dimensions conditions, for the New Disease conditions the reverse was true. Simple main effects analyses revealed that the differences were significant only within the New Dimensions condition, t (87) = 2.10, p <.05. Dunette's test revealed that both the New Dimensions group that received a dimension-organized passage and the New Diseases group that received a name-organized passage recalled significantly fewer items than the Countries control condition. Table 2 contains the appropriate d values. There were no significant

Insert Table 2 here

differences among the conditions on the multiple choice test.

Experiment 2

The results of Experiment 1 suggested that the effect of an organizational change between the first and second passages varies with the nature of the structural relationships between the passages. When the interpolated passage presents new information about previously studied entities a change in organization increased interference. When new information about a new set of entities was acquired, a change in organization did reduce interference. However the results of Experiment 1 were based on only a limited number of subjects and the control condition was presented only in a name organized version. Experiment 2 was planned to confirm the results of Experiment 1.

Design: Experiment 2 essentially replicated Experiment 1. There were two substantial changes. A second control condition which received a dimension-organized version of the Countries passage was included in the design. Also subjects were given both immediate and delayed retention tests. Experiment 2 was run partly in Cortland, New York and partly in Ames, Iowa. Because of possible differences in the Cortland and Ames samples, location was included as a blocking factor in the design. The data were analyzed as a 3 (Content) X 2 (Passage Organization) X 2 (Location) X 3 (Trials) analysis of variance with repeated measures on the last factor.

Subjects: The individuals in Experiment 2 were from two distinct samples. One sample was composed of students attending the 1974 summer session at the State University of New York at Cortland and persons from the Cortland community who responded to advertisements posted on bulletin boards and placed in the local newspaper. The advertisements promised two dollars for participation in the experiment. The second sample was composed of students taking lower level psychology courses at Iowa State University, Ames, during the 1974 Fall quarter. These persons were also paid two dollars for their participation. Persons in the Cortland sample (N = 44) varied from high school students to middle-aged housewives ranging in age from about 16 to 50. In the Ames sample (N = 55) all

were undergraduate students in their late teens or early twenties.

Results

Learning Trials: There were no significant differences between any of the groups in learning Passage 1; only the effect of trials was significant, F (2,174) = 114.17, p <.01, MSE = 6.80. Per trial the means collapsed over conditions were: Trial 1, 11.2; Trial 2, 15.2; Trial 3, 16.9. For Passage 2, significant main effects for Passage Organization and Trials were obtained, however, these effects must be interpreted in the light of significant Content X Passage Organization, F (2,87) = 8.72, p <.01, MSE = 42.80 and Content X Trials, F (4,174) = 4.04, p <.01, MSE = 7.09, interactions. Table 3 presents the relevant means. Name-organization proved superior to Dimension-organization, but the differences were large and in that direction only for the Countries content (Table 3A). Of course, recall increased over trials, but apparently at a faster rate for the Countries content than for the two Disease contents (Table 3B). Thus the significant interactions appear to be due primarily to differences between Disease and Countries passages. Since the Countries Content were intended to serve merely as a filler task for the control groups, no attempt had been made to equate difficulty of the Disease and Countries passages. Therefore it is not surprising that subjects learned the different passages at different rates. The extent to which subjects organized the second passage by name was computed for the third recall trial on the second passage. Virtually all subjects who did not organize by name organized by dimension. Table 4 presents the mean percentages. Dimension-organization of the passage led a majority of the subjects to recall by dimensions, however a significant number of subjects did not. The differences between name-organization and dimension-organization are significant for each level of Content. Table 4 presents the means.

Insert Table 4 here

Retention Tests: Separate analyses were made for the recall and multiple-choice retention tests. On the recall test, significant interactions of Content X Passage Organization, F (2,87) = 3.30, p <.05, and Content X Passage Organization X Place X Time of Testing were obtained, F (2,87) = 4.38, p < .05. The four way interaction involves differences in the pattern of results between the Cortland and Ames samples and is theoretically uninteresting; it will not be discussed further. (The Content X Passage Organization X Time of Testing interaction is not significant if Place is not included in the analysis.) The Content X Passage Organization interaction is theoretically interesting. Table 5 lists the means for each group collapsed over Place and Time of Testing.

Insert Table 5 here

The pattern of results is similar to Experiment 1. When subjects studied the New Dimensions second passage with Name-organization, recall of the first passage was better than when the New Dimensions second passage was organized by dimensions. Dimension-organization of the New Diseases second passage led to better recall of first passage than did name-organization. When the Countries passage was organized by dimension recall of the first passage was poorer than when the Countries passage was organized by name. Tests of the simple main effects of Passage Organization at each level of Content revealed that only the difference between the means for the New Diseases content were significant, t (87) = 1.75, p <.05, one-tailed. Dunnette's test of the difference between the control and experimental means revealed a significant difference between the name-organized New Diseases group and the name-organized control, d (6,87) = 3.15, p <.05.

Experiment 3

Design: Experiment 3 replicated Experiments 1 and 2, but involved the addition of a second passage Content level, a change in recall procedure, and

the addition of a third substantive variable. In Experiments 1 and 2 the effect of a change in organization varied with the structural relationship between the first and second passages. We wondered what the effect of a change would be when subjects were cognizant of the underlying structure of the passages and were asked to recall using that structure. Experiment 3 examined that question. The subjects in Experiment 3 were asked to recall the material by placing the attributes into appropriate locations in a 5 X 4 matrix.

Retroactive inhibition may very well vary with availability of retrieval cues. To test this possibility the availability of the entity and dimension names during recall was manipulated. Half the subjects in each condition were given recall pages on which the entities and dimensions were named, for the remaining subjects the matrices on the recall pages did not include the entity and dimension names.

The design can be conceptualized as a 4 (Content) X 2 (Organization) X 2 (Presence of Names) analysis of variance. An unweighted means analysis of this type was used for the recall data. Since subjects received three learning trials, the learning data were analyzed using a 4 X 2 X 2 X 3 (Trials) unweighted means analysis of variance.

Procedure: There were two procedural differences between Experiments 1 and 2 and Experiment 3. In Experiment 3 the passages were prepared on transparencies and presented via an overhead projector. Instead of having a blank page to free recall the passage, the recall pages consisted of a 5 X 4 matrix in which subjects wrote the appropriate attributes.

Scoring: Since subjects in the Names Present conditions were given the names at recall, only correct pairing of attributes with countries were counted. The maximum score is 20, instead of 25 as in Experiments 1 and 2.

Results

Learning Trials: For passage 1, the only significant effects obtained were for Trials, F (2,306) = 371.4, $p < .01$, MSE = 4.84; Presence of Names, F (2,153) = 142.04, $p < .01$, MSE = 24.40; and their interaction, F (2,306) = 16.5, $p < .01$, MSE = 4.84. Of course, recall increased over trials ($\bar{X}$ = 10.88, 15.15, 17.34, respectively) and the Presence of entity and dimension names enhanced recall (Names Present = 17.09, Names Not Present = 11.82). The interaction is not interesting as it seems to be due to a ceiling effect. By the third trial, recall is virtually perfect in the Names Present conditions but still improving in the Names Not Present Conditions.

Several sources of variance proved significant in the analysis of the passage 2 data. However most of these effects seemed related to the differential difficulty of the second passages noted in Experiments 1 and 2. Presence of cues again proved significant, F (1,153) = 70.14, $p < .01$, MSE = 24.98; Names Present = 16.57, Names Absent = 12.83; as did Trials, F (2,306) = 479.04, $p < .01$, MSE = 5.05, Trial 1 = 10.50, Trial 2 = 15.64, Trial 3 = 17.94.

Recall Data: The only factor that proved significant for the recall data was Presence of Names, F (1,153) = 54.04, $p < .01$, MSE = 8.78. Subjects who had names available averaged 19.28; those lacking names at recall averaged 15.9. Table 6 contains the means for each condition.

Insert Table 6 here

Discussion

The original impetus for this study was to determine if a result obtained with list learning could be generalized to more complex learning situations. Andre, Anderson, and Watts, (1974) had found that changing the organizational strategy subjects employed for potentially interfering tasks substantially

reduced interference. The present study attempted to see if an organizational change could similarly reduce interference with prose materials. Such a finding would have been educationally valuable because it would have suggested techniques for reducing forgetting in schools. The Content variable (New Dimensions vs. New Diseases vs. New Disease-and-Dimensions) was included for nontheoretical reasons; it was possible to manipulate this variable, we did so. We had confidently expected that name-organization would produce more interference than dimension-organization for both the New Diseases and the New Dimensions second passages.

The results of the present studies have shaken that confidence. Apparently Passage Organization interacts with the content relationships between the original and interpolated passages. A change in organization will reduce interference when one type of content relationship holds; but may produce interference when a different relationship exists.

These passages were based on matrix structures whose axes consisted of entities and dimensions of those entities. Considering only the experimental groups in Experiments 1 and 2, two types of content relationship existed between the first and second passage. For the New Dimensions conditions the entities axis remained unchanged in the first and second passages, while new dimensions were introduced in the second passage. For this type of relationship, a change in organization apparently increased interference; the mean for the New Dimensions group that received a dimension organized second passage was lower in both Experiments 1 and 2, although the difference was significant only in Experiment 2. For the New Diseases condition both the dimension and entity axes were changed from passage 1 to 2. For this type of relationship an organizational change worked as expected; the groups with dimension-organized second passages recalled more than the groups whose second passages were organized by names.

A theoretical explanation of these results must be based on an understanding of the encodings subjects produce to represent the passages in memory. Several studies have suggested that when passages of this type are organized by name subjects encode a series of entity names each associated with an unordered list of attributes, (Frase, 1973; Myers, et al, 1973, Perlmutter & Royer, 1973). If this conceptualization is accurate subjects in the name-organized New Dimensions condition should have learned to associate a second list of attributes to each name when they studied the second list. This would appear to be an analogue to the situation in free-recall research when a subject learns two successive lists each composed of items from the same taxonomic categories. Each category name has two lists of category members associated with it; retroactive inhibition occurs when subjects attempt to recall the first list (Andre, Anderson, & Watts, 1974). On this basis we expected interference for the name-organized New Dimensions condition. However, little interference was found for that condition.

One factor we had not considered was that the attribute-values associated with the disease names in the name-organized New Dimensions conditions were not as related as items in a common taxonomic category. The attribute-values belong to separate categories (dimensions); this characteristic makes the attribute values much more discriminable than members of a taxonomic category. Such discriminability might allow subjects in the name-organized New Dimensions condition to keep separate the two lists of attribute-values and recall them independently. Previous list research has shown that increasing discriminability reduces interference (Abra, 1969, 1970; Keppel, 1968).

The interference that occurs in New Dimension-dimension organized groups may be related to the interference found in the part-to-whole free recall task (Tulving, 1966; Tulving & Osler, 1967). Subjects often learn a dimension-organized passage as serially ordered lists of entity names and dimension values

(Myers, et al, 1973). However, subjects may have had difficulty doing so after learning the name-organized first passage. The disease names occurred in both passages, but would have served different functions in the retrieval schemes when one passage was name-organized and the other dimension-organized. When subjects try to recall the first passage, the overlap in disease names could produce confusion between the retrieval schemes for the first and second passages.

The discriminability hypothesis does pretty well in explaining the results for the New Diseases-and-Dimensions (New D-&-D) conditions. For these conditions, our original ideas about organizational change were confirmed. When the New D & D passage was organized by dimensions, interference was minimal; when presented in a name-organized version, substantial interference occurred. Disease names would serve as important cues in the retrieval sequences in the passage when the passages were organized by name. Since the Disease names were probably relatively unfamiliar to the subjects, the subjects may have had difficulty maintaining a discrimination between the names in passage one and two when both are learned using name-organization. Increased difficulty of list discrimination produces greater interference (Abra, 1969, 1970; Keppel, 1968). When the second passage was dimension-organized confusion would be minimized. Since neither names nor dimensions overlapped between the first and second passages, there would be little chance of the kind of confusion between the organizational schemes that was suggested for the dimension-organized New Dimensions condition.

One interesting aspect about the interference occurring in the New D & D condition is that it occurred above the level of specific item associations. In all previous studies of interference with prose materials, interference occurred only when the passages taught specific competing associations; that is, only when the two passages taught competing answers to the same questions

(Anderson & Myrow, 1971; Bower, 1974). This was not the case for the New D & D condition as there were no specific associative relationships between the first and second passages; both the disease names and dimensions were changed from passage 1 to passage 2. The passages were related only in that they were both concerned with the same general topic. The finding of non-specific interference gives us insight into the general processes by which meaningful material is forgotten. When two lessons present relatively unfamiliar information of low discriminability which may be subsumed under the same general topic heading and the presentation organization is similar in the two lessons, interference is likely to occur.

The performance of the control groups was especially interesting. The countries groups that received name-organization suffered little interference; recall was high for this group in Experiment 1, where it was the only control group; and in Experiment 2 where it was one of two control groups. When the information was very different, not related on either dimension or entities, continuing with the same organization had little effect on retention. Experiment 2 also contained a dimension-organized control group, performance for this group was lower than for the name-organized control. While the difference only approached significance, it was curious. Should this difference truly exist, it would suggest that a change in organization may increase interference even when the contents of two passages were quite unrelated. While such a conclusion must remain very tentative, the control group difference is certainly suggestive for future research.

The results of Experiment 3 provide interesting insight into the nature of the interference processes that occurred in Experiment 1 and 2. In Experiment 3 subjects were told about the underlying matrix structure of the passage and asked to recall using this structure. Under these recall conditions, no interference was found. It cannot be argued that this failure to find

interference effects occurred merely because of ceiling effects. It is true that performance was virtually perfect in the Names Present conditions; but performance was not perfect in the Names Absent conditions. In these latter conditions there was room for interference effects to exert themselves. No interference occurred for the Names Absent conditions

We think the difference in results between Experiments 1 and 2 and Experiment 3 lies with the way in which subjects represent the passages in memory. When the underlying structure is not made apparent, the passages are encoded as unorganized lists (under name organization) or as serial lists (under dimension organization). The disease names serve as retrieval cues, but in ways that allow them to be confused from passage to passage. When the underlying structure is available, discriminability of the disease names is easier since their relationship to the structure is apparent. The increased discriminability leads to less interference. This effect is probably similar to one found by Royer et. al. (1975). Royer et al. (1975) found interference when the persons described in a passage were unfamiliar. When familiar historical figures' names were substituted, interference was reduced. The familiar figures names were more easily discriminable and retrievable; this reduced interference.

It might be argued that the effects demonstrated in this research are too unreliable to support such conclusions. In part this criticism may be justified. The differences were not very large in either Experiment 1 or 2 and the pattern of significance varied between the studies. For the New Dimensions condition, name-organization was significantly better than dimension-organization in Experiment 1, but not in Experiment 2; for the New Diseases condition, the reverse was true. However, the direction of differences was the same in both experiments and the overall interaction test was significant in both. In addition both the dimension-organized New Dimensions condition and the name-

organized New Diseases conditions differed significantly from the control mean in Experiment 1. This suggests that those groups did suffer interference. In Experiment 2 the name-organized New Diseases condition was also significantly inferior to the name-organized control; a fact that also suggests interference. The dimension-organized New Dimensions condition did not differ from its appropriate control group, dimension-organized Countries. However this may reflect the fact that performance of the dimension-organized control was also low. There was at least a suggestion that the dimension-organized control suffered interference compared to the name-organized control. It should be further noted that only a limited number of subjects were available in Experiment 1 (31) which sharply reduced the power of the significance tests. Sufficient subjects were obtained for Experiment 2 but they came from a very diverse sample. The wide diversity in the sample increased error variance: i.e., the between subjects error variance was about four times larger in Experiment 2 than Experiment 1. Such increased variance would also adversely affect power. These considerations argue for the strength rather than the impotency of the variables. If the variables are powerful to produce effects under such unfavorable conditions, the effects can only appear stronger when noise is less.

We also think the present studies are valuable because they point out a technique for examining how the structural relationships in passages influence learning, retention and forgetting. Prose differs from standard laboratory tasks (free recall, paired associates) primarily because of the increased structural complexity. Many theorists have not fully appreciated the fact. Certainly we did not when we initiated these studies. The techniques used in the present studies offer methodological procedures by which the effects of structure can be investigated. The present studies point to an area of investigation that is likely to yield valuable results for understanding the nature

of memorial representation of information gained by reading. We hope the methodological contribution will prove as valuable as the substantive contribution of these studies.

A second concern is the generalizability of the present findings. The experiments are based upon passages that were written to conform to matrix structures of a specialized nature. Such structures probably only partially represent the "typical" structure of prose passages used in educational situations. Certainly most natural prose would present more complex structures than those used here. However the general idea of a matrix structure seems appropriate for many instructional situations. Often similar information about a series of topics is presented. In studying different states or countries, agriculture, industries, political systems etc. are usually discussed. In chemistry, students must learn valences, atomic weights, numbers for many elements. Other examples can be readily conceived. In each of these cases an entities by dimensions matrix seem to adequately represent the underlying structure.

To the extent that they are generalizable, the present results offer one major suggestion for educational practice. The greater the students awareness of the underlying structural relationship in material, the less likely will be forgetting. Techniques for increasing encoding in terms of the underlying structural relations should increase retention.

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Table 1

Matrix Structures for the Passages Used in Experiments 1 and 2

Entities

1A First Passage

	Organ Effected	Symptom	Cause	Prevention
silicosis	lungs	shortness of breath	inhalation of dust	face masks
pancreatitis	pancreas	abdominal pain	bile in duct	chewing food thoroughly
varicella	skin with blisters	itchy rash	chicken pox virus	no prevention
bacillus	throat	sore throat	death of mucous membrane	avoidance of infected person
rubeola	reddish-purple spots on body	fever/cough	measle virus	globuline vaccine

1B New Dimensions Content

	Age Group	Duration	After Effects	Treatment
silicosis	18-65 yrs.	life	loss of lung capacity	no treatment
pancreatitis	any age group	4-6 days	more frequent occurrence	drugs inhibiting pancreas
varicella	7-18 yrs.	14-21 days	chance of skin disease	calamine lotion
bacillus	over 6 months	3-4 wks	none	pencillin
rubeola	10-21 yrs.	10-14 days	pneumonia	cough mixtures and compresses

1C New Diseases Content

	Organ Effected	Symptom	Cause	Prevention
otitis Media	ear	dizzyness	infected eardrum	Cleaning ears
paroxymal Arrhythmia	heart	high blood pressure	defective gene	digitalis
iritis	eyes	blurry vision	blood clot	avoiding blows to head
parotelus	larynx	laryngitis	lesions on vocal cords	flu shots
roseola	face & scalp	loss of hair	hormonal imbalence	tyoprin

Table 1 continued

Matrix Structures for the Passages Used in Experiments 1 and 2

1D New Diseases-and-Dimensions Content

	Age Group	Duration	After Effects	Treatment
otitis media	13-21 yrs.	4-5 wks	deafness	ear drops
paroxymal arrhythmia	middle-aged persons	2-3 days	interference with circulation	drug heparin
iritis	18-35 yrs.	1-2 wks	damage to vision	cortisone eye drops
parotitus	3-5 yrs.	12-24 days	ear and throat infections	bed rest
roseola	9 months to 3 years	7-17 days	scars on hands face	aspirin

1E Countries Content

	Climate	Soil	Product	Landscape
Anglar	monsoons	damp	rope	flat
Kemja	Tropical	rich	aluminum	rolling hills
Decar	desert-like	sandy	oil	open plains
Tigar	wet	limey	automobiles	coastal lowlands
Kucking	artic	poor	aircrafts	rugged

Table 2

Mean Number of Items Recalled on the Retention Test and d values for Dunnette's Test for Comparisons Between Experimental and Control Groups in Experiment 1

Content	Organization	N	Mean	d
New Dimensions	Name	9	20.8	0.0
New Dimensions	Dimension	5	16.3	2.54*
New Diseases	Name	6	15.6	2.88*
New Diseases	Dimension	7	18.6	1.34
Countries	Name	4	20.8	--

*significantly different from control mean, $p < .05$.

Table 3

Relevant Means for the Significant Interactions for

The Passage 2 Learning Data in Experiment 2

A. Means for Content by Passage Organization Interaction

Content	Passage Organization	N	Items Recalled
New Dimension	Name	17	14.4
New Dimension	Dimension	19	14.0
New Diseases	Name	16	13.0
New Diseases	Dimension	17	12.5
Countries	Name	12	10.9
Countries	Dimension	18	18.0

B. Means for Content X Trial Interaction

Content	Trials		
	1	2	3
New Dimension	10.7	14.4	17.6
New Diseases	8.2	13.8	16.2
Countries	9.7	15.8	19.9

Table 4

Percent of Name Organization for the Last Trial of Passage 2 in Experiment 2

	Second Passage Organization		
	Dimension	Name	Z*
New Dimensions	35.0	95.0	4.76
New Diseases	38.0	100.0	5.08
Countries	50.0	100.0	3.45

*Z test of a difference in percentages, Guilford, 196 , all Z are significant at the .05 level.

Table 5

Relevant Means for the Significant Interaction

On the Retention Tests in Experiment 2

	Passage Organization	Recall Test
New Dimensions	Name	16.4
New Dimensions	Dimension	15.5
New Diseases	Name	12.6
New Diseases	Dimension	15.5
Countries	Name	17.8
Countries	Dimension	15.1

Table 6

Mean Attributes Recalled and Number of Subjects in Experiment 3*

	Organization			
	Name		Dimension	
	Names Present	Names Absent	Names Present	Names Absent
New Dimensions	19.0/10	15.3/8	18.3/13	17.1/11
New Diseases	19.4/11	16.6/10	19.2/11	14.7/9
New Diseases-and-Dimensions	19.3/11	15.8/9	19.7/11	15.0/10
Countries	19.4/11	15.0/9	19.8/11	17.6/12

*The number before the slash is the mean; the number after the slash is the number of subjects in that cell.